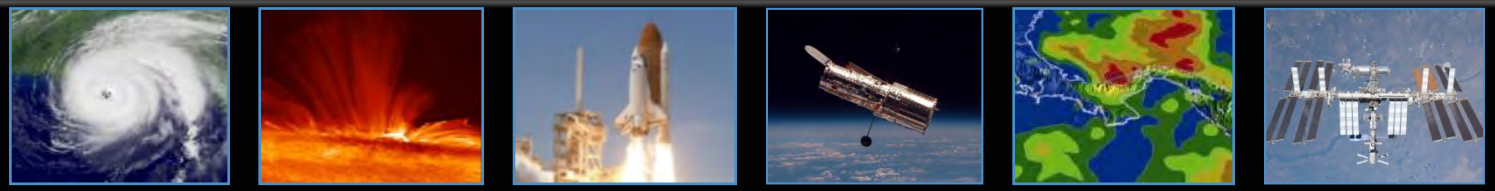
National Aeronautics and Space Administration

NASA's Space Launch System and Orion Multi-Purpose Crew Vehicle

NASA Industry Day
Southern Maine Community College

Sharon Cobb, Ph.D.
Assistant Program Manager
Space Launch System (SLS) Program
NASA Marshall Space Flight Center
May 23, 2012



Space Launch System

NASA Vision

To reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind.

NASA Strategic Goals

✔ ***Extend and sustain human activities across the solar system.***

✓ Expand scientific understanding of the Earth and the universe in which we live.

✓ Create the innovative new space technologies for our exploration, science, and economic future.

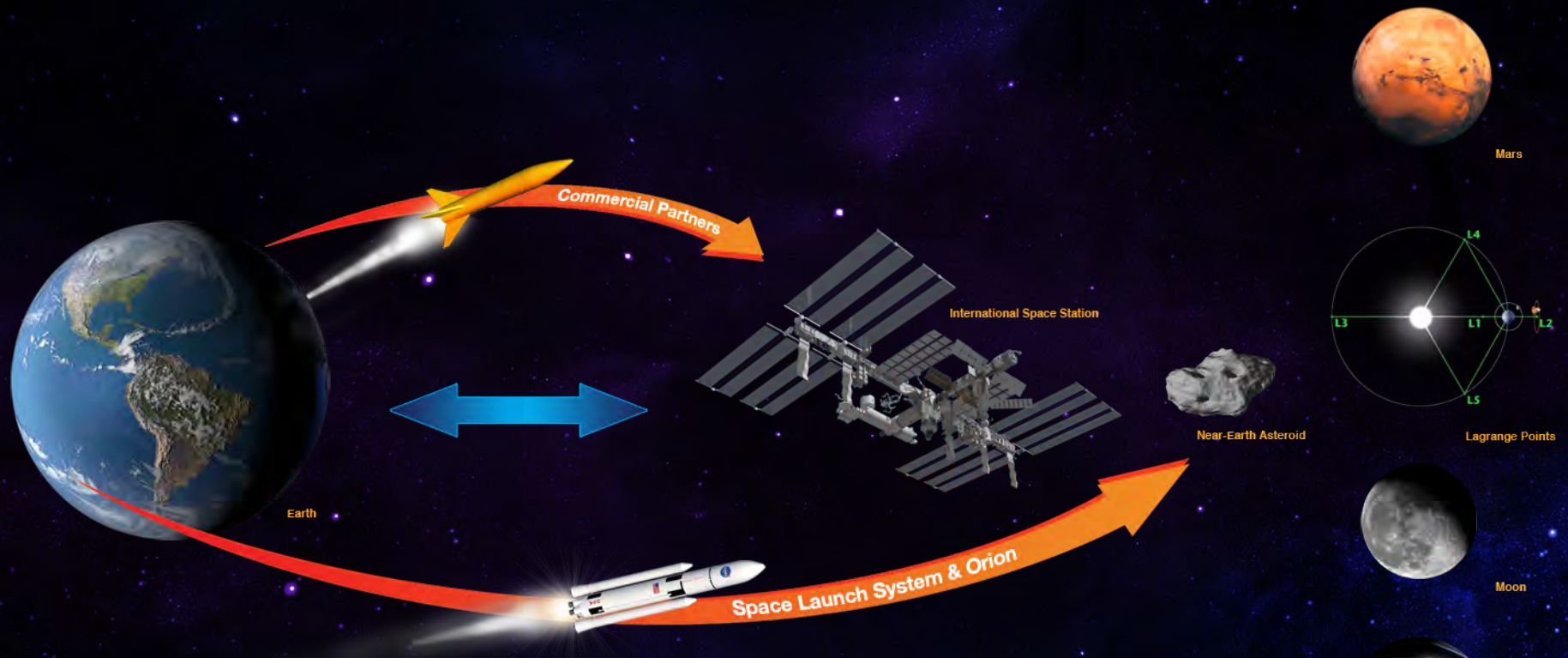
Advance aeronautics research for societal benefit.

✓ Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.

✓ Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy.

SLS — Safe, Affordable, and Sustainable

The Future of Exploration



My desire is to work more closely with the human spaceflight program so we can take advantage of synergy…. We think of the SLS as the human spaceflight program, but it could be hugely enabling for science.

— John Grunsfeld, Associate Administrator
NASA Science Mission Directorate
Nature, Jan 19, 2012

A National Asset for Stakeholders and Partners

NASA's Direction from Authorization and Appropriations Bills

- **The National Aeronautics and Space Administration Authorization Act of 2010:**
  - Bipartisan support for human exploration **beyond low-Earth orbit (LEO)**
- **Directs NASA to develop the SLS:**
  - As a follow-on to the Space Shuttle.
  - To be able to access cis-lunar space and the regions of space beyond LEO to enable the U.S. to participate in **global efforts to develop this increasingly strategic region**.
- **Provides a series of minimum capabilities that the SLS must achieve:**
  - Initially lift 70 metric tons to LEO
  - Be evolvable to 130 metric tons or more
  - Lift the Orion spacecraft
  - Back up commercial crew and cargo services for the International Space Station (ISS).

This rocket is key to implementing the plan laid out by President Obama and Congress in the bipartisan 2010 NASA Authorization Act.
— NASA Administrator Charles Bolden
September 14, 2011

Delivering on the Laws of the Land … and Obeying the Laws of Physics

SLS Driving Objectives

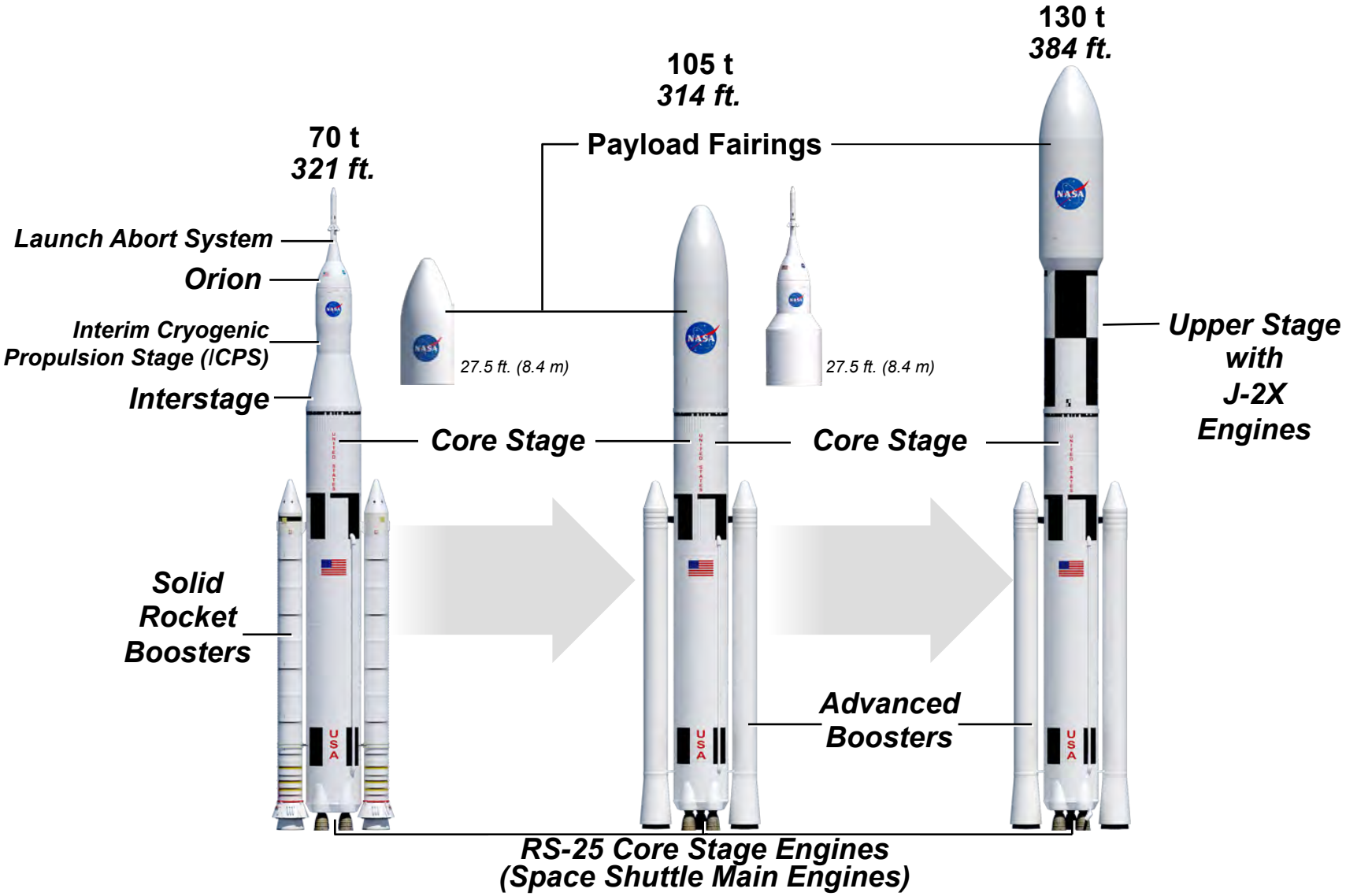
- **Safe: Human-Rated**

- **Affordable**
  - Constrained budget environment
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Competitive opportunities for affordability on-ramps

- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and exploration missions
    - Provides back-up capability for crew/cargo to ISS
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Modular and flexible, right-sized for mission requirements

Flexible Architecture Configured for the Mission

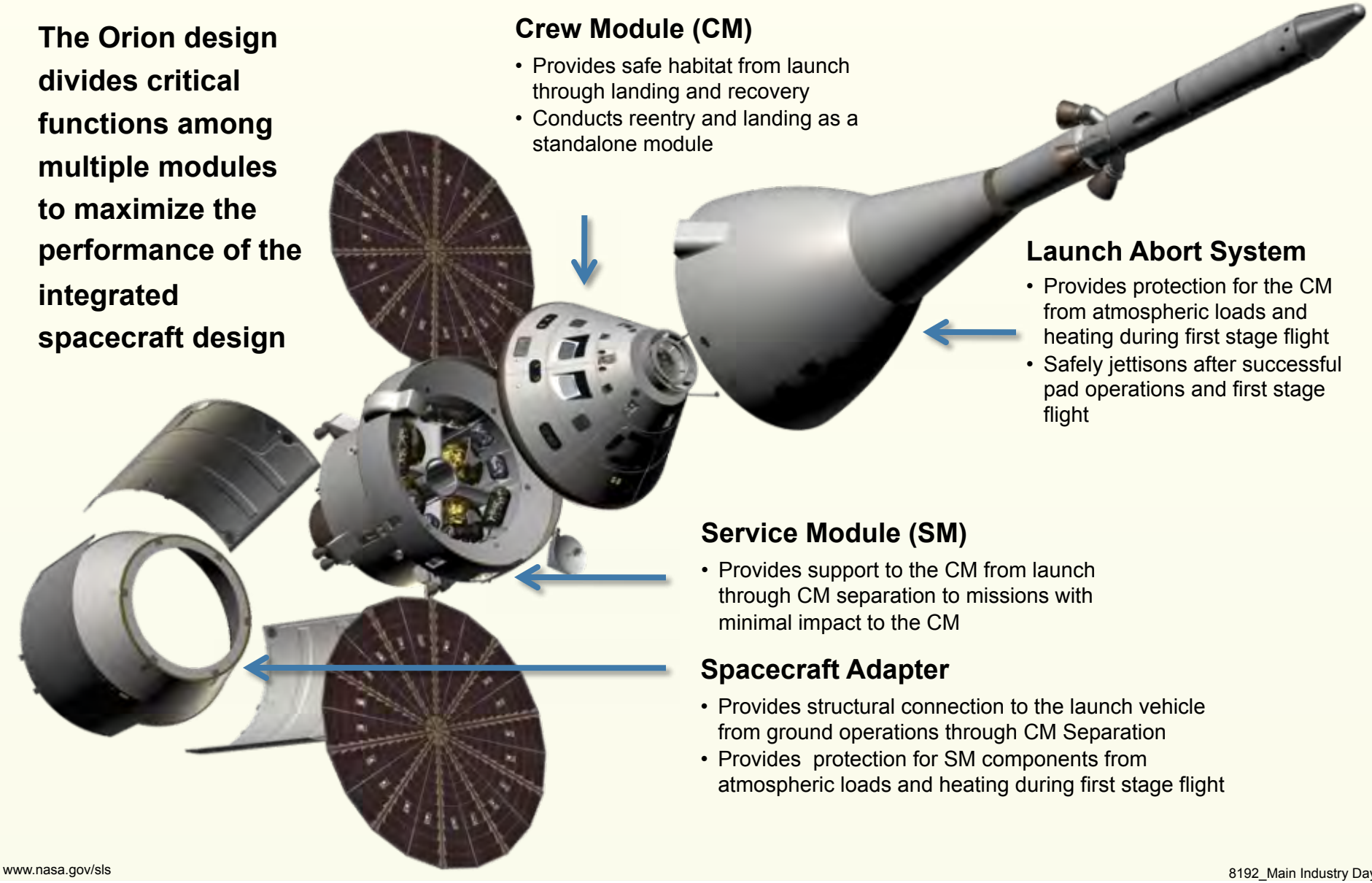
SLS Architecture Block Upgrade Approach



Starting with Available Assets and Evolving the Design

Orion Spacecraft Overview

The Orion design divides critical functions among multiple modules to maximize the performance of the integrated spacecraft design



Crew Module (CM)

- Provides safe habitat from launch through landing and recovery
- Conducts reentry and landing as a standalone module

Launch Abort System

- Provides protection for the CM from atmospheric loads and heating during first stage flight
- Safely jettisons after successful pad operations and first stage flight

Service Module (SM)

- Provides support to the CM from launch through CM separation to missions with minimal impact to the CM

Spacecraft Adapter

- Provides structural connection to the launch vehicle from ground operations through CM Separation
- Provides protection for SM components from atmospheric loads and heating during first stage flight

Orion Launch Abort System

Static ground test of attitude control thrusters

Static ground test of primary abort motor

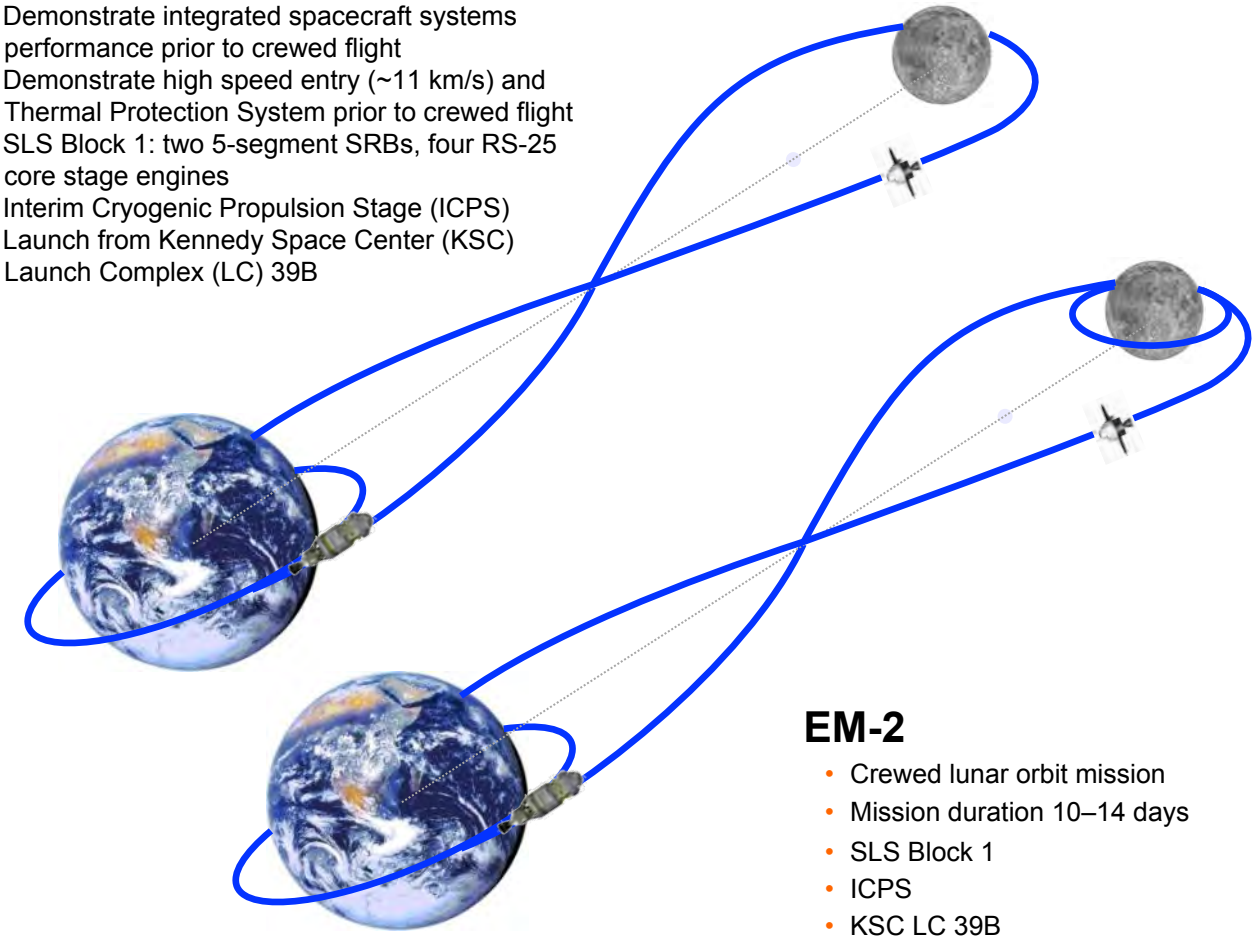
Pad Abort Test

Inert LAS prior to Orion thermal environment testing

Initial Exploration Missions (EM)

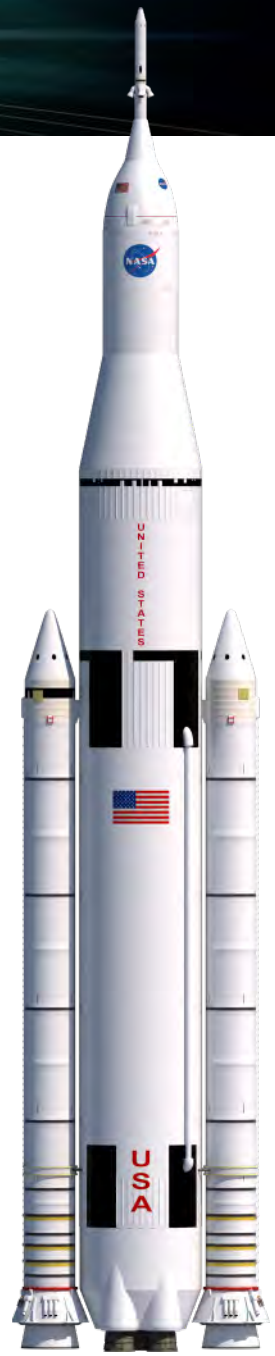
EM-1

- Un-crewed circumlunar flight – free return trajectory
- Mission duration ~7 days
- Demonstrate integrated spacecraft systems performance prior to crewed flight
- Demonstrate high speed entry (~11 km/s) and Thermal Protection System prior to crewed flight
- SLS Block 1: two 5-segment SRBs, four RS-25 core stage engines
- Interim Cryogenic Propulsion Stage (ICPS)
- Launch from Kennedy Space Center (KSC) Launch Complex (LC) 39B



EM-2

- Crewed lunar orbit mission
- Mission duration 10–14 days
- SLS Block 1
- ICPS
- KSC LC 39B

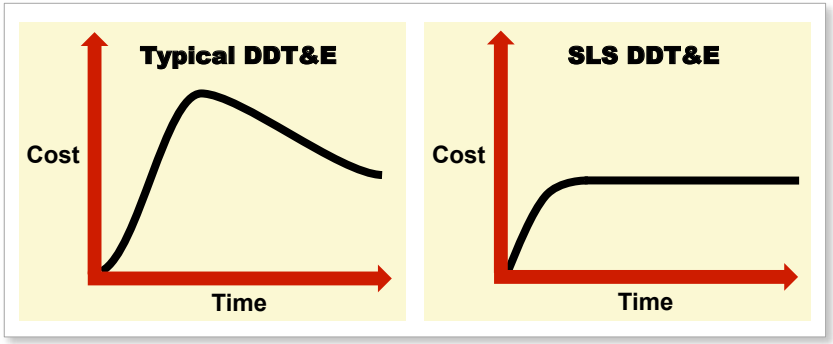


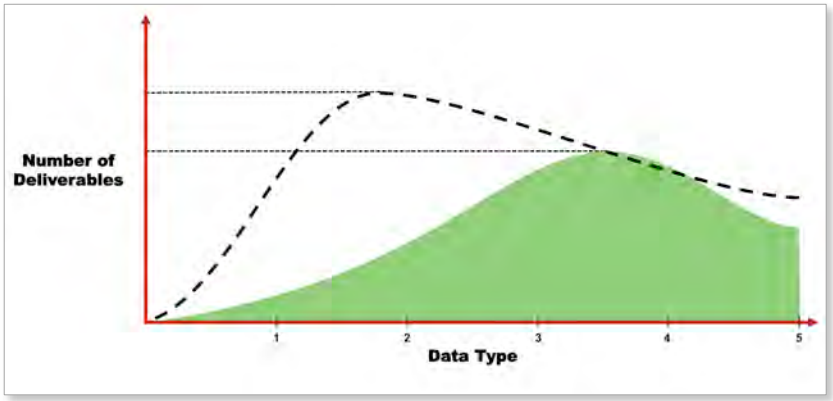
Assets in Inventory and Testing in Progress

First Flight 2017

SLS Affordability Begins with Accountability

- Lean, Integrated Teams with Accelerated Decision Making
- Evolvable Development Approach
- Robust Designs and Margins
- Risk-Informed Government Insight/Oversight Model
- Right-Sized Documentation and Standards





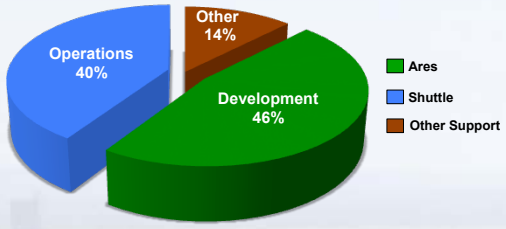
Focuses on the Data Content and Access to the Data

Affordability: The ability to develop and operate the SLS within the National means, to sustain funding for the Program.

SLS Program Organization at MSFC

042512

Marshall Workforce Supporting SLS



A Learning Organization Dedicated to Doing Things Differently

Program Manager Todd May

Deputy Manager Jody Singer

Associate Program Manager Jerry Cook

Assistant Program Manager Sharon Cobb

Hard line programmatic

Matrix relationship

Chief Engineer (CE) Garry Lyles

Deputy CE *Vacant* (ED01)

Program Planning & Control Acting Manager Jerry Cook

Deputy Manager Daryl Woods

Strategic Development Manager Steve Creech

Chief Safety Officer (CSO) Rick Burt

Deputy CSO Dan Mullane

Procurement Manager Earl Pendley

Boosters Manager Alex Priskos

Deputy Manager Bruce Tiller

Engines Manager Mike Kynard

Deputy Manager Sheryl Kittredge

Stages Manager Tony Lavoie

Deputy Manager John Honeycutt

Ground Operations Liaison Manager Brian Matisak

Assistant Manager Andy Warren

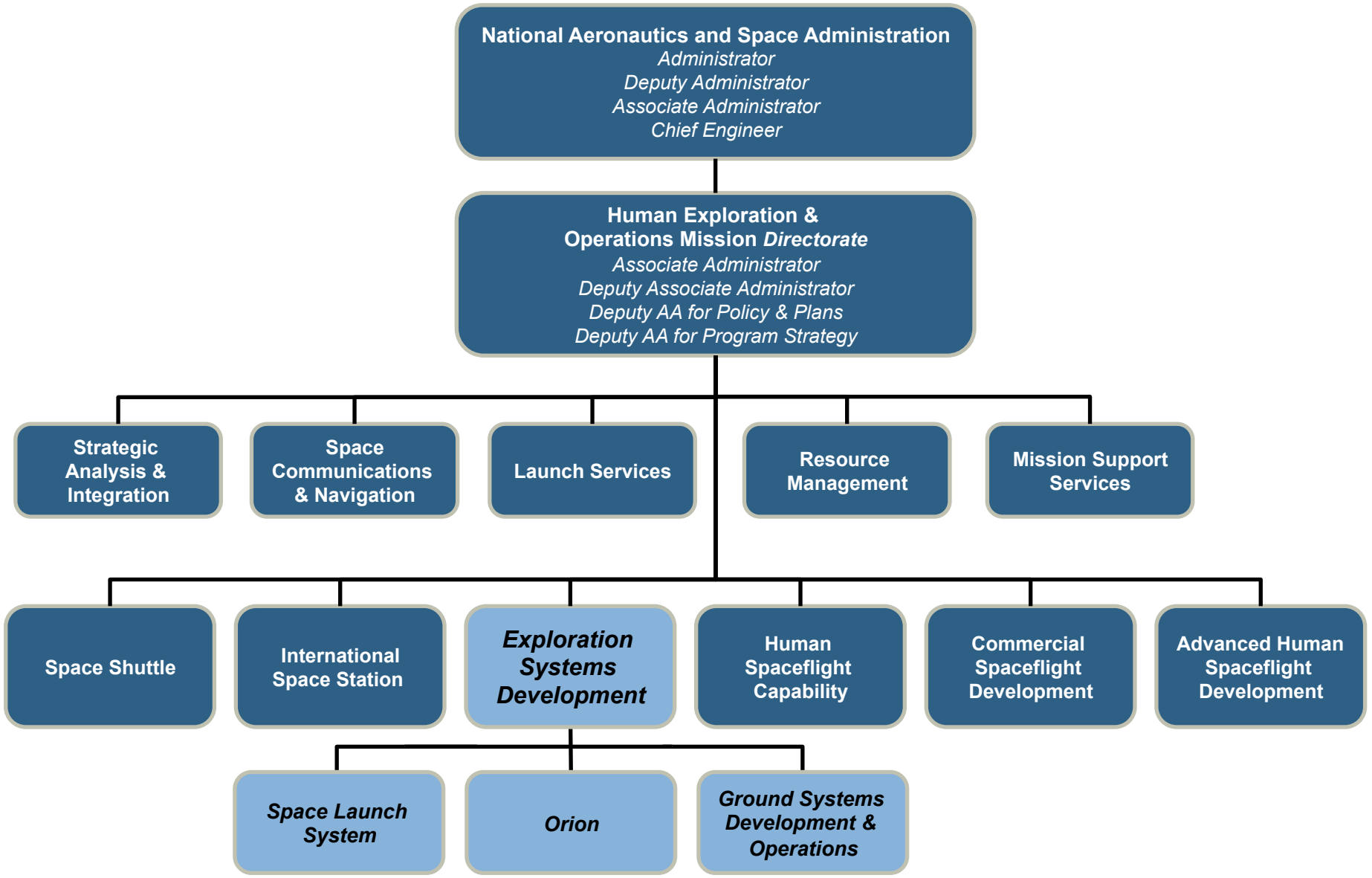
Advanced Development Office Manager Fred Bickley

Assistant Manager Tim Flores

Spacecraft & Payload Integration Manager David Beaman

Assistant Manager Craig McArthur

Programmatic Authority Flow



Initial Planning Manifest

Element	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22
Flight Manifest			Exploration Flight Test-1				Dec 2017 EM-1 (Uncrewed) Block 1			Aug 2021 EM-1 (Crewed) Block 1	

- Capable of performing heavy-lift human and scientific exploration for missions of national and international importance.
- Additional Orion and science missions will be scheduled after Agency study is completed.

Space Launch System – Steady Progress

SLS Industry Day at U.S. Space & Rocket Center

Stages Industry Day at Michoud Assembly Facility

"Pass the Torch" Lecture at U.S. Space & Rocket Center

J-2X Test, Control Room Monitoring

Engineers and technicians install the J-2X powerpack into the Stennis Space Center (SSC) A-1 test stand

RS-25D in the Engine Processing Facility at Kennedy

First J-2X Stability Test: 80-sec duration test firing; NASA began characterizing the rocket engine's combustion stability

J-2X 500-sec test firing at SSC

Stages Element Progress

Completed Orbiter Vehicle (OV) 103 Main Propulsion System Hardware Removal

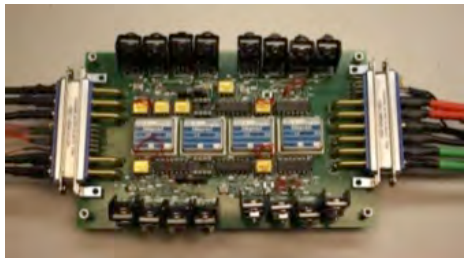
- Orbiter hardware reuse study indicated significant cost and schedule savings.
- OV-103, OV-104, and OV-105 hardware removal in process.

Thrust Vector Control Auxiliary Power Unit

NASA Budget Rollout at the Michoud Assembly Facility

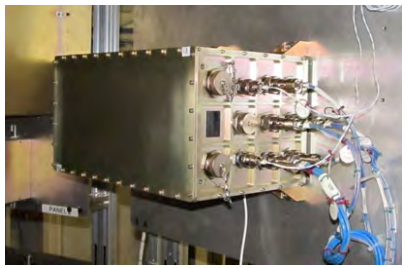
Avionics Developments

- Completed early prototype design and development for high-risk items.



PTS Prototype

3 Channel RPC Prototype



Redundant Inertial Navigation Unit

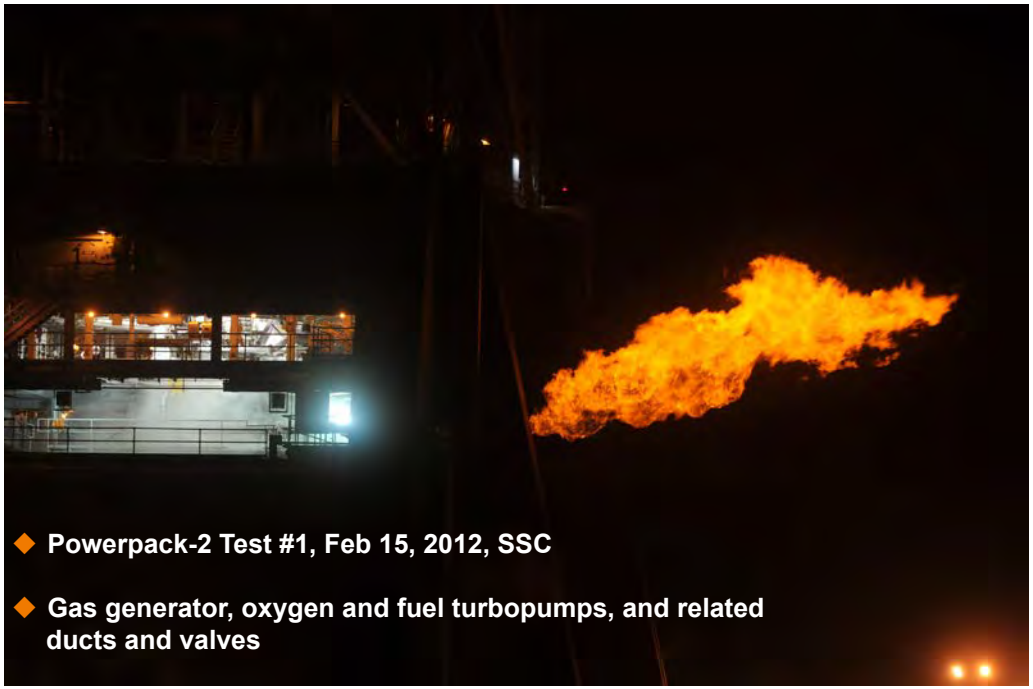
- **Fabricated and demonstrated Power Transfer Switch (PTS) and Remote Power Controller (RPC) prototypes in April 2011.**
- **Completed long-cable test simulating Mobile Launch Equipment in Nov 2011.**
- **Completed initial integration with flight software.**

Booster – Steady Progress

- **Development Motor-3 (DM-3) Static Test**
  - DM-3 was successfully conducted on September 8, 2011 at ATK, which concluded the development motor testing. Qualification Motor #1 (QM-1) is currently scheduled for Spring 2013.
- **Value Stream Mapping (VSM)**
  - SLS Booster and ATK have conducted VSM reviews on all five major motor production areas (metal refurbishment, insulation, propellant, nozzle, and final assembly).
    - Approximately 750 total changes identified to eliminate sources of waste
    - More than 400 moves eliminated
    - 46% cycle time improvement
- **Qualification Readiness Review (QRR)**
  - The SLS Booster team has completed Qualification Readiness Reviews (QRR) on each major motor component (case, propellant, liner, insulator, nozzle, final assembly) to establish the motor's baseline for QM-1.
- **Qualification Motor-1 (QM-1)**
  - Refurbishment of QM-1 metal hardware is progressing, with insulation layup underway on the forward segment. Casting operations are scheduled to begin in July 2012. The QM-1 static test is scheduled for Spring 2013.
- **Booster Requirements Review (BRR)**
  - The BRR examines the functional and performance requirements defined for the system and preliminary program plans. The primary objective of this review is to ascertain the adequacy of the efforts in defining system requirements and plans that will satisfy the mission or set of missions. Planning is underway, and the BRR is currently scheduled for June 2012.

DM-3 Static Test

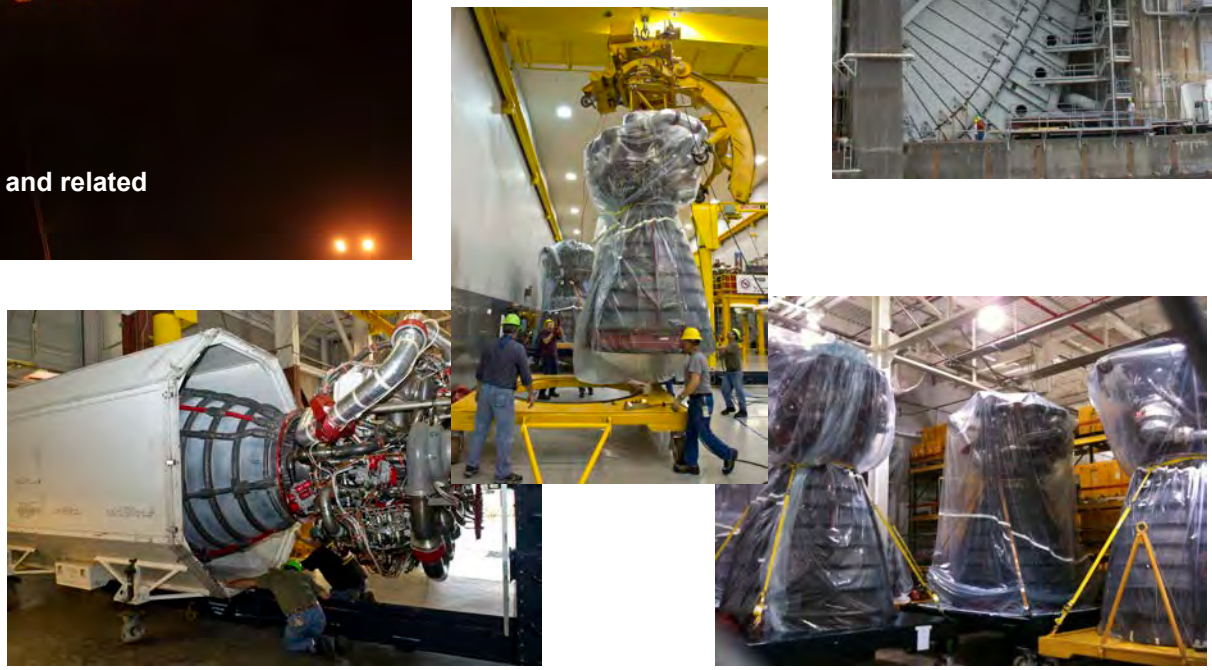
Liquid Engines Element Progress



- Powerpack-2 Test #1, Feb 15, 2012, SSC
- Gas generator, oxygen and fuel turbopumps, and related ducts and valves

- Reinstalling J-2X E10001 in A-2 test stand at SSC.
- Preparing for second engine test series.

- J-2X E10001 Nozzle Extension for second engine test series in A-2 .



Transporting RS-25 core stage engines from Kennedy Space Center to storage at SSC.

SLS Program Progress

- **NASA Pre-Formulation Phase Completed**
  - ✓Requirements Analysis Cycle Studies — Feb 2011
  - ✓Broad Agency Announcement Studies — Mar 2011
  - ✓Mission Concept Review — Mar 2011
  - ✓Agency Announced SLS Architecture Decision — Sep 2011
- **Procurement Activities**
  - ✓Acquisition Strategy Meeting — Jul 2011
  - ✓Procurement Strategy Meeting — Sep 2011
  - ✓SLS Industry Days — Sep 2011- May 2012
  - ✓Prime UCAs Signed — Dec 2011
  - ✓Integrated Acquisition Teams Initiated — Jan 2012
  - ✓NASA Research Announcements (NRA)
    - ✓Advanced Development Proposals Received — May 2012
    - ✓Advanced Booster Proposals Received — Apr 2012
  - ✓ICPS Procurement Strategy Meeting — Mar 2012
- **System Requirements/Definition Review**
  - ✓Step 1 — March 2012
  - ♦ Step 2 — May 2012
- **Design Analysis Cycle 2 Kick Off** — May 2012

NASA's Space Launch System Summary

- **Vital to NASA's exploration strategy and the Nation's space agenda.**
- **Key tenets: safety, affordability, and sustainability.**
- **System Requirements Review/System Definition Review in progress.**
- **Partnerships with Exploration Systems Development (HQ), Orion and Ground Operations Programs, and Centers.**
- **Prime contractors on board, engaging the U.S. aerospace workforce and infrastructure.**
- **Competitive opportunities for innovations that affordably upgrade performance.**
- ***On track for first flight in 2017.***

National Aeronautics and Space Administration

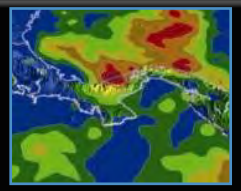
Space Launch System (SLS) Program Acquisition Overview

SLS Industry Day
Southern Maine Community College

Earl Pendley, Manager
Space Transportation Support
Procurement Office
NASA Marshall Space Flight Center
May 23, 2012







Space Launch System

Path to the SLS Acquisition Plan

- The NASA Authorization Act of 2010 (PL 111-267, Oct. 11, 2010) requires that NASA deliver a Space Launch System (SLS) with at least 70 t of initial capability and 130 t of evolved capability.
- The President's FY12 Budget Request included funding for SLS.
- The FY11 Appropriation Act included funding for SLS.
- NASA selected an architecture in June 2011 to meet the Authorization Act.
- NASA conducted an Agency-level SLS Acquisition Strategy meeting in July 2011.
- NASA conducted Procurement Strategy Meetings in mid-September 2011.
- Prime contractors were given authority to proceed in December 2011.

This rocket is key to implementing the plan laid out by President Obama and Congress in the bipartisan 2010 NASA Authorization Act.
— NASA Administrator Charles Bolden
September 14, 2011

SLS Acquisition Strategy Fulfills Legislative and Executive Branch Direction and Law

SLS Key Requirements

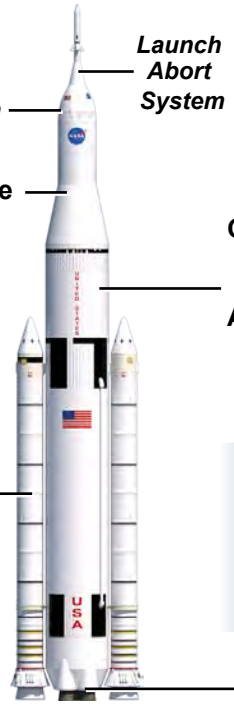
- **Affordability**
  - Flat annual budget profile
  - Existing contracts and assets used for initial capability
    - Significant hardware investments maximized
    - Significant portions of the supply chain in place
    - Work can begin earlier, engaging the U.S. aerospace workforce
    - Less design, development, test, and evaluation (DDT&E) risk and costs
    - Contract types to move to more objective incentive structures
- **Performance Margin**
  - Initial near-term capability of 70 t, evolvable to 130 t
  - Modular flexible architecture that may be configured for mission needs
  - Significant National capability
- **Evolvable**
  - Competitions for technology infusions and vehicle upgrades for future capability

SLS Will Be Safe, Affordable, and Sustainable

Acquisition Strategy

INITIAL CAPABILITY, 2017–21

EVOLVED CAPABILITY, Post-2021



Interim Cryogenic Propulsion Stage
- Sources Sought Solicitation released Jan 9

5-Segment Solid Rocket Booster
- In-scope mod of Ares contract with ATK

Core/Upper Stage
- JOFOC to Boeing (Ares Upper Stage mod)

Avionics
- In-scope mod of Ares contract with Boeing; consolidated with Stages contract

Advanced Development
- NRA: Full-and-Open Competition in FY12

RS-25

Core Stage Engine
- RS-25 JOFOC to PWR (mod to Shuttle contract)

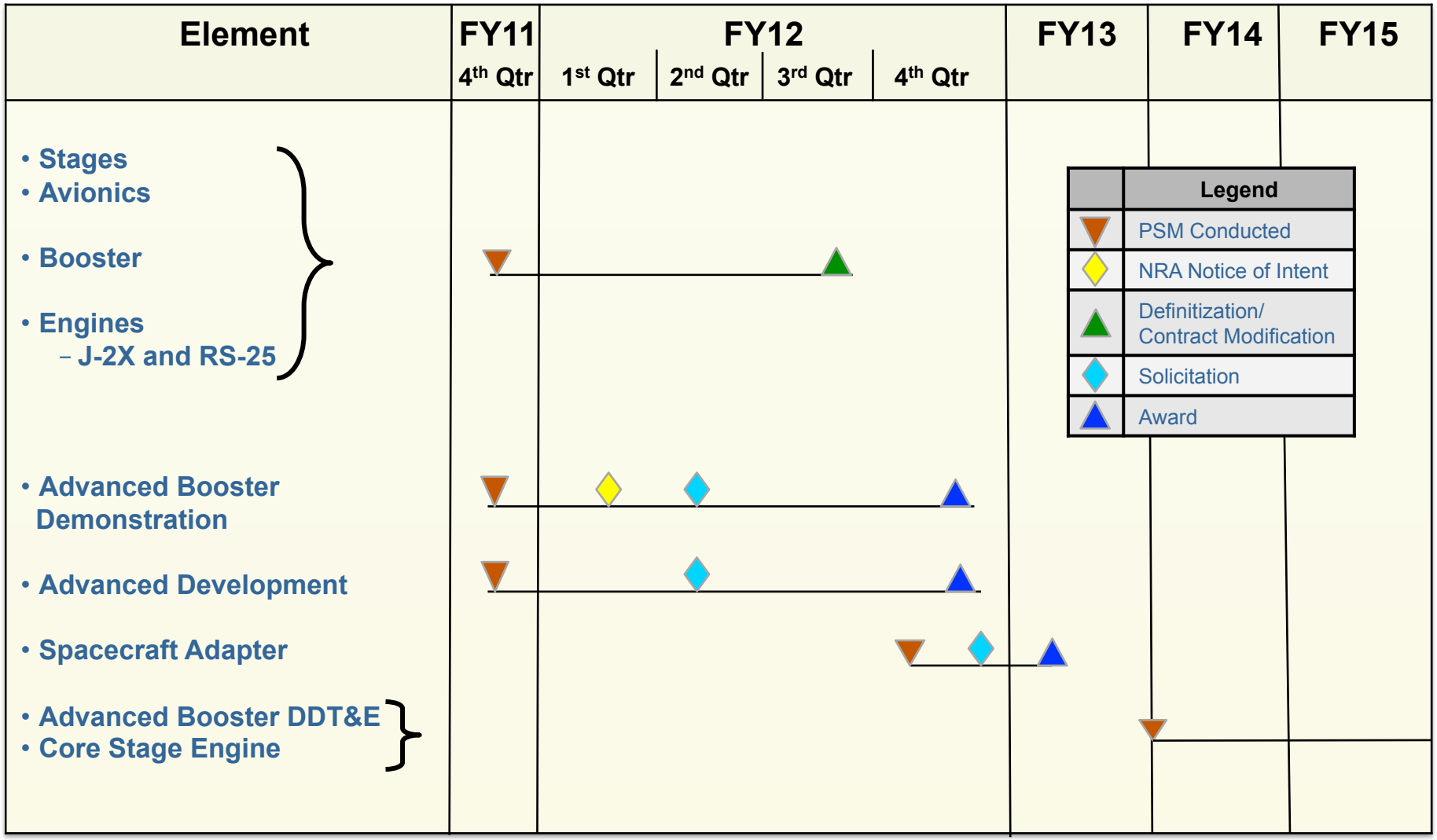
Payload Fairing
- Initial design/development in-house through PDR
- Full-and-Open Competition in FY13

J-2X Upper Stage Engine
- In-scope mod of Ares contract with PWR

Advanced Boosters
- Engineering Demo & Risk Reduction via NRA: Full-and-Open Competition in FY12; award in FY13
- DDT&E: Full-and-Open Competition, with RFP target in FY15

Future Core Stage Engine
- Separate contract activity in FY12

Procurement Schedule



On Track for First Flight in 2017

PRELIMINARY

SLS Small Business Goals

- **The NASA MSFC Small Business Specialist has performed a NASA Policy Directive 5000.2C uniform methodology assessment for the appropriate SLS requirements:**
  - Stages
  - Engines
  - Advanced Booster
  - Advanced Development
- **Subcontracting plan goals for existing contracts will be updated via negotiations.**
- **Small business utilization performance is evaluated on both incentive fee and award fee contracts.**
  - Mentor/Protégé Program will be included
- **SLS will provide topics to the Small Business Innovation Research (SBIR) Program.**
  - Link to the NASA SBIR website will be listed on all solicitations
    - http://sbir.gsfc.nasa.gov/SBIR/SBIR.html

Targeting Robust Small Business Partnerships Through Various Channels

SLS Acquisition Summary

- **The SLS acquisition strategy is consistent with Legislative and Executive branch direction.**
- **The acquisition strategy meets key SLS requirements of *safety, affordability, and evolvable performance.***
- **SLS will continue to work closely with NASA's Office of Small Business Programs to maximize opportunities for all parts of the Agency's socio-economic programs.**
- **Contact information: Earl Pendley**
  - Phone: 256-544-2949
  - email: george.e.pendley@nasa.gov

For More Information

www.nasa.gov/sls